

# REFRACTORIES FOR THE GLASS INDUSTRY

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## BASIC TRENDS IN DEVELOPMENT OF PRODUCTION OF REFRACTORY MATERIALS FOR THE GLASS INDUSTRY IN RUSSIA

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The basic refractory plants in Russia that manufacture refractory products for glass companies and the materials made by them are presented. The basic trends in development of refractory production are examined.

The production volumes and advances in the technology for preparation and use of refractories, as well as their quality, have traditionally been determined by the requirements of the iron and steel industry, which currently consumes approximately 65% of world production of refractories [1], while only 15% of refractory products are consumed by the glass industry. As a result, the demand for refractories in this sector has been satisfied by materials developed for the needs of the iron and steel industry, and glass works have been supplied with refractories of inferior quality.

In the 1990s, enterprises in the domestic refractories industry were characterized by a high level of physical wear and obsolescence of the basic equipment, commercial aluminosilicate, Dinas, and periclase and periclase-chromite refractories for which the technical level and quality did not satisfy current requirements. From 1990 to 2000, production in almost all of the leading sectors of the industry decreased significantly in Russia, and this negatively affected refractory companies. The total production volume of refractory products dropped by 3.5 times. Since 1990, some of the refractory shops, especially those manufacturing chamotte articles, have been saved, while many works in the Center and districts near Moscow have closed due to lack of demand [2].

Qualitative changes in the approach to production, radically increasing efficiency, and focusing on manufacturing refractories that satisfy the increasing requirements of industry sectors were necessary for surviving in a market economy. These problems could only be solved by retooling the enterprises, which would really allow mastering new types of products and raising the quality of the refractories to the level of world standards.

The 10 largest manufacturers are now responsible for more than 85% of the total production volume of refractory products in Russia. The leaders in the sector are Magnezit Co. Combine and Borovichi Refractories Combine Co.

Magnezit Combine is part of the Magnezit group, which also includes Kyshtym Refractories Plant Ltd. and two refractory plants in China – Dalmond Yangkou Refractories Co., Ltd. and Wuxi Nanfang Dalmond Refractories Co., Ltd. The combine specializes in manufacture of refractories of magnesite composition and makes more than 350,000 tons of refractory articles and more than 700,000 tons of commercial powders each year. For this purpose, 2.5 million tons of raw material is mined and processed each year [3].

Technical re-equipping of the raw material base and the plant is now being conducted at the combine, and it has all of the necessary modern manufacturing equipment for producing a wide assortment of quality refractory products that satisfy current world requirements.

Borovichi Refractories Combine Co. is oriented toward supplying refractory materials to enterprises in the iron and steel complex and annually manufactures more than 300,000 tons of aluminosilicate refractory articles. The product line includes more than 50 brands and over 2500 standard sizes of chamotte, mullite, and mullite-corundum items [4]. The combine is actively developing and introducing production technologies for new types of refractory products. To do this, a research section – the Center for Improvement of Technologies and Production is operating at the Combine.

In addition to these combines, specialized companies are included in the ten leaders – Bogdanovich Refractories Co., Dinur Co. (Pervoural'sk Dinas Plant), Semiluki and Sukhoi Log Refractories Plants, Podol'skogneupor Co., and refractory plants in large metallurgical combines – Magnitogorsk, Nizhny Tagil, and Chelyabinsk.

<sup>1</sup> Ogneuporkomplekt, Moscow, Russia; Saratov Glass Institute OJSC, Saratov, Russia; Semiluki Refractory Works, Semiluki, Voronezh oblast, Russia.

**TABLE 1**

Consumer of products from Podol'skogneupor Co.	Heating unit in production of	Material	Site of unit	Operating time
Saratov Glass Institute Co.	Float glass	NTsOB(B) NTsOB(BK) NTsOB(K), roasted and unroasted	Burner blocks	More than 12 months
Rostovsteklo Co. Saratovstroisteklo Co.	Container glass Float glass	NTsOB(K), roasted NTsOB(B) NTsOB(BK) NTsOB(K), roasted and unroasted	T-shaped checker brick Burner blocks	Since December 2002 More than 4 months

Dinur Co. is the largest manufacturer of silica refractories and materials. The company supplies glass works with its own traditional products – Dinas articles for lining the domes of glass furnaces.

The most widespread types of refractory articles in Russia demanded by almost all sectors in the industry are refractories of aluminosilicate composition – chamotte, high-alumina, and corundum. The largest Russian manufacturers of this kind of refractory are Borovichi Refractories Combine, Bogdanovich Refractories Co., and Semiluki Refractories Plant.

The volumes of aluminosilicate refractories manufactured by metallurgical combines are also important, but they are basically for their own needs.

Large-block chamotte items for lining the lower level of the glass furnace bath are the most demanded chamotte articles in the glass industry. Until 2005, this was a monopoly of Podol'skogneupor Co. At the end of 2005, due to closing of production in the plant, no companies manufactured this product in Russia.

As for castable materials (special refractories of baddeleyite–corundum composition for lining glass furnace tanks), only three companies are oriented toward manufacturing them – Shcherbinka Electrosmelting Refractories Plant Co., Podol'skogneupor Co., and Domodedovo Electrosmelting Articles Plant Co.

Podol'skogneupor Co. began selling low-cement concrete articles for different glass furnace elements in 2002 (Table 1) and was the only Russian company offering a line of refractories for construction and maintenance of glass furnaces until 2005. The company presently only manufactures fusion-cast items and has sufficiently high potential for expanding their assortment and mastering production that meets the requirements of modern glass-melting technologies.

The demands for other special-application items used in production of container glass (feeder refractory ware or so-called “drop-forming” ceramics) have been satisfied by imports up to now.

However, the recently noted intensive growth in production in the glass industry could not force refractory companies to turn attention to this sector of the industry and begin

development of technologies and production designed for the demands of this sector. Magnezite Combine is manufacturing molded chamotte items of the so-called potter's type of periclase and periclase–spinel compositions for packing for glass furnace regenerators.

Manufacture of a similar periclase–spinel, chamotte, and mullite–corundum product has been set up at Borovichi Refractories Combine. The Combine manufactures refractory items with Podol'skogneupor Co. technologies: chamotte bottom block and light-weight and ultralight-weight construction articles [5].

The Semiluki Refractory Plant is now the company that has most fully taken advantage of its opportunities in developing and mastering production of refractories for the glass industry. The first Russian refractory plant, the company began to deliver low-cement concrete articles for lining different glass furnace elements (Table 2). Since 2004, feeder refractory ware has been used in many glass works: pans, rotating cylinders, plungers, glass stirrers. Since 2005, it has supplied the bottom blocks for glass works – slabs for lining the bottom of the glass furnace. The articles are made according to “concrete” technology from low-cement concrete of chamotte composition. The technology developed by plant specialists provides for production of articles with quality indexes as good as the indexes of chamotte blocks made with the classic technology and even better on many indexes such as thermal conductivity and TCLE.

The entire manufacturing cycle for the bottom block is oriented toward fabricating articles with minimum tolerances with respect to geometric dimensions. This allows making bottom blocks of all standard sizes directly based on the customer's designs, by-passing bench assembly at the manufacturer's, i.e., the customer obtains a furnace bottom package that he can assemble himself without resulting to mechanical processing of the articles during assembly. Since the beginning of 2005, 500 tons of block have been delivered to glass works. Today the company is beginning manufacture of molded articles for packing the regenerators of glass furnaces of the potter's type with a 37–72%  $\text{Al}_2\text{O}_3$  content. The articles have high physicochemical indexes and minimum tolerances with respect to the geometric dimensions. In

TABLE 2

Plant using Semiluki Plant Products	Type of heating unit	Conditions of use			Area of lining, m <sup>2</sup>	Material	Unit site	Time in operation
		specific take-off, kg/m <sup>2</sup> per day	maximum operating temperature, °C	depth with respect to glass melt, mm				
Sital Co. (Smolensk obl.)	Furnace with transverse flame direction	2000	1550	1350	99.0	VShBS	Melting tank bottom covered with bakor plate VMKS-76 VMLS-65	Since June 2005
	Furnace with horse-shoe-shaped flame direction	1800	1530	1000	30.0	Same	Same	Since December 2005
	Furnace with transverse flame direction	2000	1550	1350	99.0	"	Bottom of melting tank covered with bakor plate Burner block Kit for feeder channels	Startup in May 2006
Klin Glass Container Co. (Zapрудnya)	Furnace with horse-shoe-shaped flame direction	1900	1580	1300	70.0	VShBS	Bottom of melting tank covered with bakor plate VMKS-76	Started up in April 2006
Grodno Glass Works Co. (Belarus)	Same	900	1530	No data	25.6	VShBS	Bottom of melting tank covered with bakor plate Burner blocks, loading pocket arches, feeder channel ceiling plates	Started up in June 2006
Saratov Glass Institute Co.	Tin melt float bath	150 tons*	500 – 600	–	–	SVN-5	Bath suspended output screen, gas space	June 2004
Svet Co., Skopino, Chadogoshchensk, Borisov, Solnechnogorsk, and other works	Container and medical glass production	–	–	–	–	VKS-95	Articles for feeder refractory ware: rotating cylinders, pans, plungers, goggles, etc.	9 – 18 months and more

\* Daily output with respect to glass melt.

addition, technology for production of chamotte construction lightweight brick with an apparent density of 0.5 to 1.3 g/cm<sup>3</sup> and mechanical strength of up to 25 N/mm<sup>2</sup> has been mastered at the company.

Bottom block technology for lining tin melt baths – the heating unit used in production of polished glass on a tin melt – is currently being started up at the company together with Saratov Glass Institute.

Sukhoi Log Refractory Plant is one of the leading companies in Russia in production of heat-insulating materials and fiber articles of mullite-silica composition for use in the 1150 – 1300 and 1300 – 1425°C temperature range (roll material, felt, boards, cardboard). General-purpose aluminosilicate chamotte articles and aluminosilicate mortars are included in the inventory of chamotte articles. The company continues to expand the line of articles made of refractory fibres for heat insulation of all types of heating furnaces and their structures [6, 7].

Bogdanovich Refractories Co. has a large production base where the basic kinds of articles are manufactured: ge-

neral-purpose aluminosilicate chamotte, mullite-silica, mullite, mullite-corundum, corundum. High-alumina refractories for glass furnace feeders and production parts made by vibratory casting with Podol'skogneupor Co. technology are manufactured by the company.

In addition to the listed refractories companies, the leading glass companies have refractory production shops that basically specialize in production of refractories for their own needs. Many relatively small companies have been formed in Russia in the last ten years for the development and production of specialized and new refractory products: Bakor Co. STC, Keralit Ltd., Refractory Technologies Ltd., Riostal' Co. Metpromsnab Co., Rosogneupor Co., Kerambet NVF Ltd., Alite-Aksi Co., Kvartz Ltd., Center-Glass-Gas Co., Tsemdekor Ltd., and others [8, 9].

The analysis of the list of refractory products manufactured by Russian companies shows that many current types of articles required by consumers in Russia are not manufactured at all or are manufactured in small volumes. The shortage of such articles is covered by imports. For expanding the

assortment of domestically manufactured products, research should be conducted to improve the technologies and create new kinds of competitive articles with the optimum qualitative characteristics for the concrete consumer [10].

The spectrum of services provided to the consumer of the refractory product must be expanded, including the selection of refractories, list of equipment or parts for a single order, and bench assembly of structures of the element or the entire heating unit and delivery of articles in the required volume and at fixed times. It is also necessary to determine the performance suitability of the refractories in direct communication with the user and scientific centers such as Saratov Glass Institute, D. I. Mendeleev Russian Chemical Engineering University, V. G. Shukhov Baltic State Technical University, etc.

These services are very important in maintaining a high level of the quality of both assembly and startup operations and the glass manufacturing process and any others. In addition, the constant collaboration of the manufacturer and consumer of refractors, for which Russian refractory plants can serve as an example – Semiluki, Podol'skogneupor, etc. – is a key factor in providing glass production with not only new high-quality refractories but also assembly equipment and technology of assembling heating units.

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